REMOTE SENSING IN CHINA[1]

Report to the IDRC on the
May 17 - June 2 Technical Mission

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[1] Note: The views expressed are those of the author and do not necessarily reflect those of the CCRS or Government of Canada.

1. INTRODUCTION

The Technical Mission was to investigate the feasibility of a proposal given to IDRC by the State Scientific and Technical Commission of China (SSTCC) on behalf of the Technical Training Department (TTD) of the National Remote Sensing Centre (NRSC).

Each member of the Mission had a different, but overlapping, focus. This report addresses the National Program, linkages between groups, and the technical component of the program. Points of similarity with Canada's program are also identified. Dr. Howarth has the mandate to address education and training, while Dr. Godfrey has examined the infrastructure of the recipient agency, the SSTCC and the overall program from an aid perspective.

To obtain the necessary information, visits were arranged to all three Departments of the NRSC, three of the five universities known to be working with remote sensing (RS) in Beijing, two "user" institutes with modern facilities, the Geography Institute of the Academy of Sciences in Nanjing and the Department of Geography at Nanjing University. Many of these visits were to institutions first encountered or visited during a UN sponsored trip from January 3-31, 1984.

From these visits (see Section II and Appendix A), details on remote sensing in China were obtained. From these details, the technological basis of the program may be examined (Section 3). Section 4 addresses the integration of the National Program, while Section 5 considers the impact of the IDRC program on the Program. The detail obtained builds on the earlier UN-sponsored visit and personal contacts with Chinese scientists built up over the last few years.

Section 6 addresses the qualifications of the proposed staff, while Section 7 identifies equivalent agencies and experts in Canada.

Recommendations are given in the last section.

2. VISITATIONS

Before the Mission, IDRC requested visits to a number of institutions involved in remote sensing. These included groups located in the capital of Beijing, as well as in Nanjing. The latter were included to give a more provincial view, in addition to the view from the centre. Our hosts arranged tours to all places requested. The itinerary is given in Table 1.

For each institution visited, we obtained information on the Ministry concerned, name(s) of senior staff, lines of authority, sources of funding, relationships to other programs, number of staff and their qualifications, internal training programs, educational activities, project work carried out (or focus of activities) and the likely impact of the IDRC project.

Appendix A draws on an earlier report for the United Nations, as well as on the IDRC visit. The Appendix A is meant to stand alone as a report on remote sensing in China as seen in early-to-mid 1984. Since

Table 1 IDRC Investigation Delegation on Remote Sensing Projects Visiting Schedule May 19 - June 1 CHINA

May 19, Sat.	Arrival in Beijing
May 20, Sun.	7:00 a.m. Sightseeing: the Great Wall and the Ming Tombs Dinner at 6:30 p.m. hosted by NRSCC at Fangshan Restaurant in Beihai Park
May 21, Mon.	9:00 a.m. Conference with officials of NRSCC 2:00 p.m. Visit to the Technique Training Dept. of NRSCC (in Peking Univ.)
May 22, Tue.	9:00 a.m. Conference continued in TTD Banquet at Peking Univ. 2:00 p.m. Visit to the Technique Development Dept. of NRSCC
May 23, Wednes.	9:00 a.m. Visit to the Remote Sensing Center of the Ministry of Petroleum Industry 2:00 p.m. Visit to the Information Service Dept. of NRSCC
May 24, Thurs.	9:00 a.m. Visit to the Remote Sensing Center of the Agriculture Univ. Banquet at the Agriculture University Sightseeing in the Summer Palace
May 25, Fri.	9:00 a.m. Conference continued in the NRSCC 2:00 p.m. Visit to the Remote Sensing Center of the Ministry of Water Conservancy and Power 6:00 p.m. Banquet hosted by Water Conservancy
May 26, Sat.	9:00 a.m. Visit to TsingHua University 2:00 p.m. Lectures at the Agricultural University
May 27, Sun.	9:00 a.m. Travel to Nanjing
May 28, Mon.	9:00 a.m. Visit to Geography Institute, Nanjing 2:00 p.m. Visit to Nanjing University Remote Sensing Banquet hosted by the President, Peking University
May 29, Tues.	Tours in and around Nanjing
May 30, Wednes.	8:30 a.m. Return to Beijing Banquet hosted by Institute of Information, Academy of Sciences
May 31, Thurs.	9:00 a.m. Final Session with NRSCC 2:00 p.m. Lectures at Peking University/Meet student candidates
June 1, Fri.	6:10 a.m. Depart for Canada
June 2, Sat.	Arrive in Ottawa

I have spent six weeks working in remote sensing institutions in China between January 1 and June 1, the report likely provides more detail on the total program than has been available before in Canada.

3. TECHNOLOGICAL BASE OF THE CHINESE PROGRAM

The Chinese program is not as simple to analyze in terms of its basis as is, for example, the Canadian program. The Canadian program has identified areas in which it has a will to achieve or maintain technological superiority measured against the rest of the world. This is usually done in co-operation with a now well developed industrial capability based on exports. Our program is driven by a co-ordinated amalgem of users, technology providers and a mix of Federal, Provincial and industrial activity.

The complexity of the Chinese program comes from two elements. First, the central government has decided that remote sensing is one of several areas of new technology which are important to the country's development. To this end, an R&D center has been set up in remote sensing.[1] With the importance given to remote sensing as a national priority, there is tremendous growth in a variety of different directions simultaneously. This complicates the study of RS in China. Secondly, the lines of authority go through ministeries in what has in the past been a bureaucratically rigid system. Until recently there has been little co-operation between ministeries. This change is slowly taking place, with some vestiges of rigidity remaining.

Overlaid on this system have been a variety of complicating factors. The most important of these has been foreign aid. It would appear that the National Centre was established at least in part to counter claims by donor agencies that there is little inter-ministerial co-operation. To ensure co-operation, the National Centre has been given control over much of the RS related funding in the country - one third of this has been given to the three Departments of the National Centre, while two thirds gives to develop equipment and to the main applications groups. Although individual ministeries do control the overall direction within their departments, provision of funds by the central remote sensing organization has resulted in more central control than one is used to seeing in China.

Aid has also had some negative impacts. In some cases foreign experts have directed equipment funding to develop capabilities in their sometimes obscure areas of interest. In other cases equipment has been purchased which does not really meet the agencies' needs.

With the infusion of aid and additional funds from the Chinese central government it has been possible to develop in many directions simultaneously. Some of these pursue avenues of dubious utility for current state-of-the-art remote sensing (e.g. chemical analyses of materials to predict signatures, and the development of a spectral

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[1] Two other centers focus on software development and electrical engineering.

signature bank). In most cases China has learned from the errors of others. However, in other cases, it seems to insist on repeating work of questionable utility.

Another "problem" has been the source of LANDSAT products. Since the Chinese do not have their own receiving station, they have purchased LANDSAT data in 70 mm transparency format. This lowest cost solution has resulted in widespread use of specially made 1:500 000 and 1:250 000 colour composite prints of generally excellent quality. Japanesé, American and now Chinese equipment has been used for this production. As a result of this data source, there appears to be widespread familiarity with and use of LANDSAT. Since there is limited "competition" with entrenched data collection systems, and many large thematic mapping projects have just begun, LANDSAT use is widening.

This group of experienced users of photographic data forms the nucleus of those wanting to expand their programs through the use of digital image analysis. The most notable of these, the Information Department of the NRSC, has just contracted for a large Canadian built system.

In the provinces, the technological base is not as strong as in Beijing - except for those groups closely tied into a Beijing based operation such as the Ministry of Water Conservancy and Hydro Electric Power. In Nanjing, we saw early-model colour additive viewers and density slicers of both foreign and Chinese manufacture. In the Geography Institute, the equipment was not properly maintained. Indeed, during the demonstration of the density slicer, the vidicon was subjected to several blasts of bright white light. The screen clearly showed the ravages of such handling in the past.

The program is much like what was found early in Canada's RS history. Some of the best work and most developed programs are in user groups who saw potential, were able to obtain equipment early, and have subsequently moved to more applications or even more advanced equipment. The Water Conservation group and Petroleum Institute both fall under this description.

In general, there is a solid and growing nucleus of staff and equipment in Beijing. In terms of equipment, the provinces' are not yet as well developed relative to the central facility as they are in Canada - although I exepct a rapid catch-up. Similarly, educational institutions outside of Beijing have less equipment.

It appears that it is easier to obtain funds for R&D in technology than in applications within both the National Centre specifically and national program generally. The NRSC digital applications program has been playing "catch-up" to user groups.

The discrepancy between technology and applications is nowhere more noticeable than in the two major educational institutions. TsingHua University, described as the MIT or CalTech of China, is the major technical/engineering university. It already has a mini-based image analysis system with Chinese software. It will soon take delivery of one of the largest commercially produced image analysis

systems in any university in the world. On the other hand, the applications oriented Peking University with 20% larger graduate enrollment in RS has a small micro based system for all of its needs (including undergraduate computer courses for geographers).

Although, the government has decided to focus on RS, it also appears to have decided to do "everything". It has, therefore, sacrificed depth in technology R&D for breadth. As in any program trying to cover all areas, some are being handled well, some adequately and some poorly. A major concern in the future will be identifying winners and losers so that China can focus on those areas it does well. By so doing, it will reduce its current reliance on imported technology and may begin to export its own developments. For this reason joint ventures are being sought with major suppliers.

Given these general statements, one can begin to focus on areas of weakness in terms of equipment. The major areas of equipment weakness fall in the applications oriented universities. They are falling behind and will continue to do so if appropriate hardware is not acquired. It is perhaps noteworthy that almost all institutes with digital image analysis equipment offer training courses of a month or more for their new employees. This indicates that a problem exists in the Universities. Graduates are not receiving sufficient instruction to allow them to begin work without substantial additional training. Graduate school is the ideal place for students to gain in-depth experience and develop problem solving capabilities. Without appropriate hardware a great educational opportunity is lost.

In the area of visual analysis there is a broad base of experience, but limited equipment to support or make optimum use of that experience. Since most equipment supporting visual analysis (such as the PROCOM-II) uses transparency format data as input, this lack is not immediately important since such data are not readily available. However, after the Chinese have their own receiving station, high quality transparency material in 9 x 9 format will become available. The increased information content of such products will only be accessible with something like the PROCOM-II.

An area of interest to almost all groups is GIS. Work in this area shows the most duplication of any area considered during the mission. This reflects back on the Ministerial rigidity described earlier. Each ministry does have a mandate for collecting and processing information in its own area of responsibility. Groups as diverse as the Research Institute on Topographic Surveying, Technique Development Department (TDD) of the NRSC, and the Agricultural University are all working on GIS related to remote sensing. None of them seem to be working together - the approaches seem to be markedly different in each. The TDD work on a small area is most comprehensive, but since it appears to be based on raster data alone, where it will lead is unclear. There is virtually no dedicated hardware for the GIS work and no linkage to an image analysis system is yet available. The Intergraph System can be linked to a DIPIX system, and this may be something to consider for TsingHua University. It may then be able to do developmental work that would link all those agencies who now have DIPIX equipment.

A central equipment related problem in the NRSC is that applications oriented R&D is being done on a system unlike any other now in use in the ministeries with operational data collection mandates. Our experience in Canada has indicated that basic R&D can be done on such single or one-off systems, but a great amount of time is wasted in converting procedures for operational use (where such conversion can be done at all). Futhermore, the synergism that develops between users of technology and developers of technology is hindered by having a variety of equipment. Standardization should be sought.

Another area of weakness concerns the university groups outside of Beijing. Although training courses in Beijing routinely draw people from the provinces, few of these have sufficient access to digital image analysis systems to become as proficient as one would expect of graduate students and faculty. Consequently, there will be a growing discrepancy in the level of sophistication available in Beijing compared to other areas. This discrepancy will be reinforced by the apparent reticence of people to locate far from their home regions. After Peking University, the most pressing requirement for an improved capability in educational institutions would be in centers like Nanjing University, where there exists the staff, some older analogue equipment, but nothing else.

A final area of weakness is in information relating to the technology. There is no central remote sensing translation service or library. Technical staff competent in English are often used (unproductively) for translating. Duplication abounds, and information distribution is on an informal basis, where it occurs at all. One of the major components of Canada's success in remote sensing is its centralized computerized library system (RESORS). Such a system would be of great benefit to China expecially if it included a translation service.

In summary, there exists the technological base from which an extremely strong program may emerge. However, for RS technology to meet its potential for resource data collection in China, five improvements to the technological base appear mandatory. First, more and better training and educational facilities are required. Secondly, China must soon identify those areas of the technology on which it wishes to concentrate national energies to do world-class R&D. Third, there should be better co-ordination between R&D and users in terms of hardware and method development. Fourth, there should be a co-ordinated approach to GIS-perhaps using an existing commercial system as a point of departure. Fifth (and last) a centralized library and translation service is needed.

4. INTEGRATION OF THE NATIONAL PROGRAM

A national program in any area of technology implies co-ordination at the national level by a responsible agency of the central government. For a program to be integrated, I believe that there must be linkages between four groups: those providing training/education, the research and development community, users of the technology and the industrial or production oriented sector.

From our study of remote sensing in China it appears to meet the organizational criteria of an integrated national program.

As noted elsewhere, the primary co-ordinating body is the National Remote Sensing Center under the State Scientific and Technical Commission of China. The SSTCC is one of several key central commissions operating with a mandate given at a high level by the central government. It controls much of the remote sensing budget in China. About one-third of its funding supports the activities (but not man years) of approximately 300 employees of the NRSC spread between three ministeries. From our study, it directly supports their equipment and operating budget to carry on training, education, R&D, applications oriented work and dissemination of satellite and airborne data. The remaining two thirds of its budget goes to main applications groups, universities (other than Peking), manufacturers and provincial groups. It also appears to be actively involved in soliciting aid support for RS from groups like UNDP, FAO and IDRC. Support to date (excluding World Bank) exceeds $1 million (US) for hardware and consultants.

The integration of the program in the face of what is usually seen as a rigid and inflexible bureaucracy may be quite surprising to be casual on-looker. However, the central government has placed a high priority on remote sensing. As a result, it has allocated a significant budget under the control of a senior level group (SSTCC) with a mandate for co-ordination. The combination of budget and high level mandate appear to be a sufficient "carrot and stick" to overcome even the most intractable bureaucratic system.

Although spending in the NRSC Departments was most obvious, others we met have received funding and/or support for worthwhile projects from the central co-ordinating group of NRSC (Ms. Zhong's assistance to Tsing Hua University, for example). Mention was also made to funding in industry for the manufacture of related hardware.

On paper, in an organizational sense, there is a well co-ordinated integrated program according to the guidelines set out above. The National Centre contains R&D, training and education, and some applications development work. As noted above, users and industry are also funded.

In reality, in an operational sense, there appears to be less co-ordination. Working level scientists and staff seem to have more allegiance to their employing ministeries and Departments. However, given the organizational and project integration, the individual opinions of staff are more likely an artifact of the Ministerial responsibility system of Chinese government and are not important except as reflected in departmental rivalvies. A certain competiveness, if properly channelled, may be argued to be a "good thing" for the success of the program as a whole.

5. THE RELATIONSHIP BETWEEN THE NATIONAL PROGRAM AND THE PROPOSED IDRC PROJECT

China has decided (quite rightly, in my opinion) that remote sensing data can help provide significant information needed to optimize their resource use for the betterment of society as a whole.

They have recognized that to make optimum use of the technology resource oriented staff should be made aware of the potentials of remote sensing through training programs. At present neither the National Remote Sensing Centre nor its component parts have the capability to provide this essential training for large numbers of people at the required level of sophistication.

The proposed IDRC funded project has as its primary objective the improvement of the capability to offer training programs to meet the national need for improved resource management decision making. Since the mandate for training has been given to the TTD, it is this group that is the recipient agency.

Although not explicitly stated in any of our meetings, there are two central areas of interest to the IDRC project: education and training. My definition of education includes the typical university post-graduate education and research program as found in Canadian or other western universities. The product of the post-graduate education component is a skilled professional who may assume a position at the advanced level in R&D or operational applications. These graduates may also perform a useful role in the second, or training component. Training is defined as extension education - "how to" workshops for those already in the workforce. In my opinion, training cannot exist independent of education if the country is to keep pace with the advancing technology of remote sensing.

There appear to be several levels of training and education in China. Individual Departments offer equipment specific courses, usually for their new employees. These cannot meet the pressing need for training large numbers of people. As well, there is technology oriented education and training. This appears to be the role set out for Tsing Hua University. They have a long history in this area and have recently made a large equipment purchase. This education and training facility appears able to provide the technology side with graduates, as well as limited retraining for those in the work force.

The remaining level of training and education addresses the resource oriented specialists-geologists, geographers, foresters, planners and agricultural specialists. The latter group, agricultural specialists, have an established program (under FAO assistance) with appropriate image analysis capabilities balanced with visual equipment in the Agricultural University. As for the other resource specialists, there are training courses, graduate courses and a large faculty at Peking University. However, their relatively simple analysis facility now being used at capacity cannot provide the level of sophistication required. In addition, the system available is not the type used for operational work. It is only of use to teach first principles to undergraduates.

A primary concern from IDRC's point of view is the capability of the recipient agency TTD to derive significant benefits, which in turn would lead to benefits to the country as a whole. This concern can, in part, be addressed by looking at what TTD has done in the past with the resources at their disposal.

From a standing start in 1975 some 3000 people have attended training courses from one to two months. Three courses per year are now given to an average 100 attendees each. The courses have been prepared on request for various agencies. For each course, materials and notes have been prepared. The remote sensing program, officially approved in 1978, now has 13 faculty and 13 staff. There are twenty six graduate students doing work which is equivalent to BA Thesis to M.Sc. level work in Canada. Their existing microbased system, now used to capacity for both RS and computer courses for geographers, is clearly insufficient to meet their mandate.

In summary on this point, TTD has used existing resources to the limit. It may be expected that they would use any further equipment to the limit as well.

A second way of evaluating the proposed project is to assess what might happen if the status quo it maintained. First, applications oriented graduate students would not have access to the same type of facility they would use in the work place. Graduates would require further retraining once employed. This would be a needless waste of resources committed to operational application, and represent a lost opportunity for the graduate students preparing themselves to perform a useful service for their country. Secondly, the training courses would not be relevant for many of the users. Many from the user community would have access to equipment and facilities for beyond the level in the university. A third result may be either loss of staff or erosion of the interest of the competent young staff being assembled. Without the training and education component of the IDRC project there would be a further loss of opportunity. The university needs both hardware and additional staff who can teach its application and understand its operation. At present only one or two junior faculty appear to have this capability. Without better facilities and better trained staff, technology will be driving applications. I do not consider such total domination of applications by technology to be a good thing for the achievement of the long term goals of the RS program in China.

In summary, present resources are well used. Additional staff and hardware are required to continue to meet the mandate of the TTD - especially in the area of applications training and education. Without this program, the ability to use existing user-oriented equipment will not keep pace with its acquisition. The pool of talent will dry up, and the whole RS program in China will falter, leading to missed opportunities.

6. THE PROPOSED STAFF FOR CANADIAN EDUCATION

Two individuals were presented to us as candidates for graduate school in Canada. One falls in the area of systems design, the other in applications.

I am not qualified to judge the program followed by the young man proposed for systems design - although he seems to be highly regarded by the faculty of Peking University. His English skills may not be sufficient.

I was surprised that Mr. Wang Ru-ye was not proposed for the systems graduate program. He is the lecturer who has set up their micro based system and appears well versed in image processing. He is dedicated to the advancement of remote sensing for the betterment of his country and is certainly fluent in English. Since he is likely to be the system manager in charge of any new hardware, I recommend that he be involved in training in Canada on the DIPIX hardware. Given his enthusiasm, I suspect that he will end up knowing more about any system acquired than the individual proposed for study in Canada. (This may be the reason he was not proposed - or perhaps there are other hidden reasons.)

My background does permit me to comment ont the qualifications of the individual proposed for the applications oriented graduate work. I first met Ms. Wang during my U.N. sponsored visit in January. Although geologically based (and thus far from my application's expertise), her work appeared to be a tidy, small study with a well defined objective, a reasonable data set and tight methodology. Her demonstration at the micro system in May was impressive both in terms of what she had accomplished since my earlier visit and the way in which she did the demonstration. She exuded quiet confidence and competence. She handled questions well and posed a few of her own. Her work would be Masters level work in Canada. I would endorse her beginning an M.A. program, with possibility for an upgrade to Ph.D. work. My primary concern would be the strength of her course work and her level of knowledge of foreign literature since they do not have an adequate library. In this regard, I would recommend that Peking University be supplied with a set of the previous Canadian Symposia on RS, the various ERIM Symposia, the Cdn. J. of RS, and CCRS technical papers.

7. CANADIAN EQUIVALENT AGENCIES AND EXPERTS

As part of the requirements of the consultancy, I have been asked to identify agencies in Canada equivalent to the recipient agency in China, the TTD of the NRSC, as well as potential Canadian experts for training courses.

Since the constitutions of China and Canada place education at different levels of government, there is no direct equivalent in Canada of the TTD. The National Program in Canada involves university faculty members as part of advisory committee, but no formal ties exist. We have, therefore, restricted our selection to those universities in Canada which have more than one or two faculty members involved in formal graduate programs in remote sensing applications. These include (west to east) University of British Columbia, University of Waterloo and McGill University. Since only the first two have full scale image analysis systems, these are the only ones truly equivalent. Expertise is also found in other institutions in selected areas of application and a major program is expected to begin at University of Manitoba. Further details will be covered in the report by Dr. Howarth.

A second requirement is the identification of specialists. The areas of interest are application of the ARIES system to a range of resource data collection problems, geographic information systems and image processing. The experts selected with a few notes on qualifications are given below.

Application of the ARIES system

1. Mr. Christian Prévost, Applications Development Section, CCRS. He is the resident expert on the ARIES system. He did graduate work on the system, has served in Upper Volta as an expert on a Canadian aid program and now heads work on crop monitoring.

2. Dr. Philip Howarth, Professor of Geography, University of Waterloo. He has worked with digital analysis for resource monitoring for ten years. His institution has an ARIES system.

3. Dr. Simsek Pala, Ontario Centre for Remote Sensing. His group has one of the largest ARIES installations in Canada. He has experience in various aspects of resource monitoring.

Geographic Information Systems (GIS)

1. Dr. Ian Crain, Chief, Canada Land Data System, Environment Canada. He is responsible for the largest GIS system in the world. He has experience in system design, management and remote sensing (as a scientist in the early CCRS program). He is a designated UN expert.

2. Dr. Roger Tomlinson, Ottawa. He has been a consultant in the application of GIS for a number of years and designed to original information system for Environment Canada. He has served as an advisor in Canada, the USA and elsewhere.

3. Dr. Michael Goodchild, Dept. of Geography, U. of Western Ontario. He has been a advisor on GIS to Environment Canada, particularly in the area of the mathematical basis of GIS.

Image Processing

1. Dr. David Goodenough, Head and Senior Scientist, Methodology Section, CCRS. He has lead the development of image analysis work at CCRS and has served as advisor/consultant to LACIE and other major international program.

2. Dr. Bob Woodham, Remote Sensing Program, UBC. He has worked for a number of years on image processing, terrain analysis and problem-oriented aspects of image analysis. He recently won a major research fellowship to allow him to give up teaching for several years to concentrate on his research at UBC.

3. Dr. Phillippe Teillet, Research Scientist, Methodology Section, CCRS. Dr. Teillet has been involved in image processng R&D for a number of years and has participated in the recent state-of-the-art work at CCRS.

4. DIPIX staff. Several DIPIX staff have expertise in this area - especially as related to their system. Their approach is not likely to be as global in perspective as the above, but some will be needed for training. Staff selected for training vary in both quality and experience and should be vetted before any are approved in terms of the training course objectives.

Virtually all of the above are known to me to be excellent lecturers with clear ideas and useful information in the context of the program. The question of who to select for GIS depends upon what the training objectives are.

8. RECOMMENDATIONS

1. The general program should be approved with a small ARIES system and the code needed to add sotfware developed in China.

2. If a larger system is considered necessary by the Chinese, they should pay for additional features.

3. A Service Contract should be obtained for the system.

4. Mr. Wang Ru-ye should be sent on a DIPIX training course.

5. A PROCOM-II should be considered as a useful device to balance the digital/visual side of applications.

6. The library of the TTD should be upgraded.

7. Centralized translation should be encouraged.

8. Further missions should provide for one day for report writing and collection of thoughts. Between meetings, official functions and travel we were kept busy for an average of twelve hours each for the sixteen day trip... which included two and one half weekends and a holiday.

Appendix A

Visits to Selected Agencies Involved in Remote Sensing in China

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The following is an attempt to provide an organized and comparable set of notes on the various agencies visited during our May 1984 IDRC Mission. This report draws on both the current and an earlier visit sponsored by the United Nations. Since a prominant educator (Dr. Howarth of Waterloo) and aid specialist (Dr. Godfrey of IDRC) were part of the most recent mission, these areas are not emphasized here.

A total of fourteen topics have been used to bring together the material so that comparisons may be drawn by the reader. All visits followed a similar pattern: a formal welcome, presentation of the hosts program, our questions, a tour, more questions by both sides, and a wrap-up session. This was often follwed by a formal banquet and further discussions. The nature of the presentations often meant that we had little or no control over the content, or time allocated to various topics. This results in some elements being incomplete. In addition, the topical outline used here was not decided on until after a number of visits had taken place.

I have not reported on two visits/meetings related specifically to Dr. Godfrey's interests in automated Chinese character recognition and technical information.

What follows provides a comprehensive view as of May, 1984 of the rapidly changing picture of the national remote sensing program in China, with the notable exception of work being done in forestry.

1. **Institution:** National Remote Sensing Centre (NRSC)

2. **Ministry:** State Scientific and Technological Commission of China (SSTCC)

3. **Mandate:** To co-ordinate and fund remote sensing R&D and applications development.

4. **Senior Officials:** Mr. Chen Weijiang (Head), Ms. Zheng Li-Zhong (Engineer), and Department Directors (noted separately).

5. **Lines of Authority/Organization:** RS is one of three R&D centers set up in new technology. It crosses into three ministeries. It has no direct line of authority, but rather a program office and co-ordinating role to avoid duplication. It provides funding.

6. **Staff/Qualifications:** The staff are knowledgeable in both a managerial and technical sense. They are highly thought of.

7. **Project Work:** The centre does project work through the departments and through external funding of activities. The budget allocation for these is 1/3 and 2/3 respectively.

8. **Equipment:** N/A - See Departments

9a **Training:** N/A - See Departments

b **Education:** N/A - See Departments

10. **Relationship to Other Program(s):** There are linkages through co-operation and funding to a variety of Departments and universities including those at Nanjing University. There are 131 institutes involved in RS (25 R&D; 33 education and 73 industrial units in agriculture, forestry and fishing). They fund work in 10 ministeries and 30 remote sensing units. These funds are in addition to individual ministeries who also fund work of specific interest to their mandate.

11. **Promising Areas of RS Work/R&D:** Their funding mechanism as a control of R&D and to reduce duplication is interesting.

12. **Impact of IDRC Project:** The project would fill a large gap in the existing national program.

13. **Primary Areas for Exchange with Canada:** The exchange would be at the National Program level. A group has already visited Canada. Mr. Chen knows Mr. Godby, D/G of CCRS. The Chinese program is very much like the Canadian - but adapted to the Chinese situation.

14. **Misc. Information and Comments:** The program was set up in 1981 as (we believe) part of a UNDP sponsored project. The program has agressively sought a variety of external funding. This has resulted in a variety of equipment recommended by foreign experts. Some of the equipment is of limited use, while in the worst cases there was no Chinese involvement in specification and procurement. This is unfortunate since expertise does exist in most areas - although there seems to be a reluctance to tap the expertise in other ministeries.

1. **Institution:** Technology Training Department (TTD) of the NRSC

2. **Ministry:** Education

3. **Mandate:** Training and education. The TTD is also named the Remote Sensing Institute (RSI) of Peking University.

4. **Senior Officials:** Prof. Shen Ke-qi (Physics) former VP Academic is Director of RSI. Vice Director is Assoc. Prof. (Geography) Ms. Chen Kai who serves as Director of TTD. Assoc. Profs. (Geography) Cheng Chi Cheng and Mao Zan You are her Vice Directors of TTD.

5. **Lines of Authority/Organization:** The RSI reports to the University, while TTD activities are co-ordinated by the NRSC.

6. **Staff/Qualifications:** The staff names are available from Dr. Howarth's report. TTD contains one professor, 6 associate professors, 6 engineers/lecturers, 6 assistants and 6 others. Fourteen (more) are part-time from other departments of the NRSC and elsewhere. To date none of TTD staff have been trained overseas, and the qualifications are, in the main, only in visual applications with one exception. (Lecturer Wang). This is the only institution visited which has not had staff overseas for training. (Ms. Chen Kai studied with Dr. Li who has a Ph.D. (1940's) from Illinois.) Qualifications of staff are largely unknown - although judging from their students' work some must certainly be competent.

7. **Project Work:** A list of graduate work was given to Dr. Howarth. Work done in TTD includes grasslands enhancements, acquatic vegetation, geology (rock type mapping), land use and related studies. Work presented in January also included expert systems and artificial intelligence. Five labs support the work: RS Physics (ground spectroscopy); Computer Image Processing (Comenco micro); RS Interpretation and Mapping (visual); Optical Processing (fourier) and a small library. (See attachments).

8. **Equipment:** An itemized list was given to Dr. Howarth. They are also users of the I^2S system at the Petroleum Institute. (Mr. Wang Ru-ye).

9a **Training:** Since 1981, 12 short courses of four weeks duration have been given to 570 people. Instructors come from the university and elsewhere. Courses are for intermediate to high level training. Since 1975, 3000 people have taken such courses. Each year, two or three are given. Groups are now smaller than they were. The average was 100 per course - it is now 50. They do not cover agriculture or forestry.

b **Education**: Education has included three elements: limited undergraduate teaching in visual interpretation for geographers; graduate courses and graduate research. The Comenco system is also used to teach programming to undergraduate geographers. Each year, 10 new graduate students are accepted. It seems most come from Beijing. At present there are 26 students. Nine have graduated to date. The graduate courses include RS Physics, Digital Analysis, Optical Image Processing, Principles of RS Information Interpretation, Infrared Sensing, Photogrammetry, Microwave Sensing, Resources and Environmental Remote Sensing and Thematic Problems. A complete list of courses and graduate R&D topics was given to Dr. Howarth. Coursework takes one and one half years as does the research. Only limited teaching materials are available. Sabins is the only foreign work available in Chinese.

10. **Relationship to Other Program(s)**: TTD uses external staff for teaching and will put on courses "on demand". Graduates are employed in TTD, NRSC and elsewhere - but primarily in Beijing. Joint work is being done with the Petroleum Institute, Ministry of Water Rsources and Hydro Electric power, the Agricultural University and others. It appears that much of the co-operation has just begun. They are limited in co-operation by their lack of resources and limited role of research. They appear to share other's facilities and data (including several multi-user test sites) and provide training and student research as their contributions. Staff and students appear to travel widely within China as resource people.

11. **Promising Areas of RS Work/R&D**: Land degradation, land use, visual interpretation and expert systems are all promising areas. The concept of a large centralized educational facility with the consequent synergism is a model for others to adopt. Only Waterloo and UBC are even remotely close, while Sherbrooke is developing a program which could become their equal with additional faculty.

12. **Impact of IDRC Project**: An up-to-date system will improve training, education and research capabilities - making all activities more relevant to the present and projected user agency plans and systems. Bright young staff are more likely to stay and perform to their capabilities, leading to more fruitful co-operation. The core of young staff will be useful. As the program develops there will be more opportunity even in a seniority based system. Developments at Tsing Hua's DIPIX system will be readily transferable - and they will have a better grasp of what R&D at Tsing Hua would be useful. Training some staff overseas will lend the program more credibility. Travel by senior staff will show them that they are developing in a worthwhile direction - it will re-inforce their present direction. Most importantly, the IDRC project will speed in-career training of Chinese specialists so that they might better apply RS technology.

13. **Primary Areas for Exchange with Canada**: The applications work is similar to that done in smaller universities several years ago in Canada. Some work on expert systems applied to visual interpretation may be useful, as is the work by Ms. Wang JinFei in geology (she was nominated for study in Canada). Work on land degradation will also be useful.

14. **Misc. Information and Comments**: The program at TTD is larger in terms of staff and graduate students than any two programs in Canada. There are as many TTD faculty members in RS as in all of Ontario's universities put together. The staff are motivated by bettering their country's lot. They are among the most dedicated people I have ever encountered. Long personal-level discussions with several staff members left me with the impression that China will make better use of RS technology than have we in Canada - and we in Canada have, in my opinion, been world leaders in a number of areas.

1. **Institution:** Research and Development Department, NRSC (also called Technique Development Department)

2. **Ministry:** Academia Sinica (Ministry not determined)

3. **Mandate:** To connect R&D in technology and applications. They are to provide direction to others on how to do R&D. They concentrate on basic theory, including spectral data integration, software application, thematic mapping, and GIS.

4. **Senior Officials:** Mr. Yang Shiren (Director); Ms. Lili (Associate Prof.) - Digital Analysis Lab (Mr. Yang's wife); Mr. He Jianbang, Head of GIS; Prof. Chen Shupeng, Earth Science.

5. **Lines of Authority/Organization:** Like other parts of the NRSC, the R&D Dept. reports through its own organization, Academia Sinica, as well as through the NRSC. This group appears to have more of a relationship to the NRSC than the other Departments - likely a result of size and level of NRSC funding. UNDP funded the Digital LogE System.

6. **Staff/Qualifications:** The staff have varied qualifications. Some appear quite capable, while others are following what I believe to be dead-ends.

7. **Project Work:** The 220 staff (115 professionals) are divided into six labs: Measurement and Analysis, Digital Analysis, Interpretation Laboratory, Computer Aided Cartography, Geographic Information System Lab, and Airborne Sensing. (See the edited commentary from my January visit.)

8. **Equipment:** LogE System, Comptal Vision 120, Nova 840, I^2S 575, various chemical analyzers, laboratory based microwave spectrometer, SLAR, 11 channel analogue MSS, multispectral camera, colour additive viewer (for photo making - from Japan), spectral measurement equipment for .4 to 1.1 μm, 2.5 and IR, solar illumination simultion lab, CCD scanner, IR (6 band) scanner, 12-15 M resolution SAR, microwave radiometer (1.5,3 & 10 cm), etc.

9a **Training:** They offer in-house staff training of 2 weeks for those using their equipment.

b **Education:** They have graduate students (as do most units of the Academic Sinica). At present there are 5-10 pursuing Masters ($2\frac{1}{2}$-3 years). 80% of the graduates stay to work. They have some staff studying overseas.

10. **Relationship to Other Program(s):** In spite of the groups mandate, they appear to have few ties to other groups, although they are a few joint projects. Others do use their equipment. In this respect they are like CCRS.

Airborne data are used more by outside groups, the in-house lab equipment is used by outsiders, but in-house use appears to be dominant. The software they develop will (they hope) be useful to many and not be machine dependent. They have some linkages to an unspecified foreign company re image processing. They also have some contacts with other countries re software.

11. **Promising Areas of RS Work/R&D:** Microwave spectroscopy, software development, photographic processing.

12. **Impact of IDRC Project:** The project will provide better applications oriented staff and may then provide a higher quality input into driving their R&D.

13. **Primary Areas for Exchange with Canada:** Microwave spectroscopy. They could learn from Canadian work in GIS and user friendly image analysis systems.

14. **Misc. Information and Comments:** The TTD was formed in 1979. There are six laboratories in the TTD. These details on the laboratories were obtained during my January visit. The observations made then are still valid.

The first laboratory, Measurement and Analysis, focuses on spectral data. The infrared and microwave receive special attention. Their spectral work includes chemical analyses to understand spectral reflectance and a microwave lab to study features such as the effect of soil moisture on microwave returns. They are developing a signature bank much like the one which exists at LARS, but here they look further out into the spectrum. Although I remain unconvinced that laboratory spectra in the visible and near IR are useful for spectral recognition in the real world, the work in microwave seems useful in gaining an understanding of this complex part of the spectrum.

The Digital Analysis Laboratory has a LogE system, a Comptal Vision 120 and a Nova 840. They are developing some of their own software for these last two, trying to link the various systems. The limitations of these processing systems compared to the more interactive analysis systems available were highlighted by Professor Yang - I fully agree with him. The main system is relatively inflexible, somewhat slow, too keyboard-dependent, and as a result does not provide optimum man-machine interactive capabilities. Our very interesting discussions on systems requirements took place at the end of our meeting and lasted well past the normal finishing time. I think that we continued for some time since we had so much in common with regard to our perception of how the field is developing, and the importance of linking R&D to user's information needs. The fact that the group clearly sees their hardware's limitations even now as they are just getting it operational was impressive. They have continued to look at other systems and now are studying their own.

Rather than be complacent with what they have, as many would be, they are looking towards future improvements or replacements. What they have now is an R&D System to test algorithms, do some software development, and hone their skills in this area. This is similar to the use to which the Canada Centre for Remote Sensing put their original Image 100 system. Out of that effort came the knowledge that has contributed to the current commercial systems. For applications method development, however, I believe that the present configuration is likely not adequate. This is especially true, considering that the users have elected to purchase I^2s and DIPIX hardware. The lesson we have learned in Canada is that it wastes time and effort when an application developed on one type of equipment must be transferred to another for general operational use. Whether or not the group needs another system depends on its role vis a vis the work at the Information Department. (I^2s has since provided a system for demonstration purposes - apparently at no cost.)

The third laboratory is the Interpretation Laboratory which houses discipline specialists who do image interpretation. I believe it was this group which uses a Japanese colour additive viewer to make very nice 1:500,000 composites from the 70 mm LANDSAT. They are doing some work on the subtropics.

The fourth group is Computer Aided Cartography. They have various foreign-built equipment for R&D to aid in their own developmental work. They have now developed their own breadboard capability using Chinese technology. Their prototype system can print ink or use a light source on photographic paper.

The fifth group is the Geographic Information System lab. They have an interesting schematic which shows the various stages in the whole process of going from raw data to a user product. Included was provision of all manner of inputs and internal inter-relationships. The attention to the end user's needs shown in the poster was quite thorough and commendable. They have applied the geographic information system for a small area study (20 km x 20 km) to monitor/estimate the area of agricultural land to be covered by a reservoir using terrain data and sources of data about the land. All data are used in a raster format. By so doing they avoid some problems now, but will unlikely be able to apply the same methods over a large area - as is their aim. The engineer showing the area and I had an interesting discussion on the possibility of replacing their digitizing step, which is tedious, time consuming, and prone to error, with a direct image-analysis system to data-base link. Although not aware that such technology had been demonstrated and is now commercially available (but expensive), he saw the potential, and an interesting two-way flow of ideas ensued.

The last laboratory is dedicated to airborne sensing. They have a Shanghai-made analogue multispectral system which they have used in several studies either together with, or separate from, LANDSAT. Their major sensor is CIR film made in China to, it would appear, fairly high standards.

After this visit, the role of the Department of Research and Development vis a vis the Information Department became clearer. It appears that the R&D group addresses problems on two levels for a range of clients.

The first level dealt with is that of the more fundamental R&D done in remote sensing centres or agencies in the USA, Canada, France, West Germany and Japan. The work in China in this Department appears to focus on expected problems in applications areas of future interest to China.

This approach appears more in common with that found in Canada and France than in the others.

The second level addressed by the R&D department is the development aspect - usually manifested in small area studies or demonstrations. This work would appear to be done for a range of clients or users. During the developmental stage, problems are solved to make the methods work. Clients, or co-operating agencies, may be various government departments - including the Information Department of the Remote Sensing Centre.

The Information Department has as its role (in the brochure on the Remote Sensing Centre) the production of thematic maps. They must either take methods developed by the R&D group or do their own small area tests before doing on to large area mapping. Since both agencies were established at the same time, to meet its mandate the Information Department had to embark on an independent program to apply the areas of technology ready to be applied. This same sort of development has happened elsewhere.

1. **Institution:** Information Department (ID), NRSC

2. **Ministry:** Research Institute of Surveying and Mapping. (The R&D arm of the 17000 member National Bureau of Surveying and Mapping doing all surveying and mapping in China.)

3. **Mandate:** The production of thematic maps and distribution of RS imagery.

4. **Senior Officials:** Mr. Li Boheng (Director) reports to Mr. Zhang Ziaorong (Director of the Institute).

5. **Lines of Authority/Organization:** As above

6. **Staff/Qualifications:** Some staff have studied overseas. Mr. Qiming Chen studied Data Base Management at UCLA, Mr. Qui Zhicheng studied at CCRS and U. of Ottawa. Mr. Li has taught at Peking University and is the technical equal in the area of applications development to anyone anywhere. At least one geography post-graduate (Ms. LiLi) is employed by the ID. Technicians and image interpreters usually hold undergrad geography degrees.

7. **Project Work:** They have mapped 13 landuses in all of China using LANDSAT colour composites at 1:250,000/1:500,000. Air photos are now being used for 49 classes. R&D on coastal zone mapping has begun using CIR and airborne multispectral photos. They are also working on grassland inventory.

8. **Equipment:** Optronics scanner, Amdahl computer with small display. Large DIPIX system is on order. They also plan to buy (or have bought) a VAX 11-780 for GIS.

9a **Training:** Staff lecture at Peking University, but only limited training takes place. The UNDP has funded courses (such as the one I gave in January).

b **Education:** The ID does not have an education component (although other parts of the Research Institute).

10. **Relationship to Other Program(s):** Mr. Li teaches in some Peking University courses. They use the I^2S at the Petroleum institute (but it is too slow fo their needs). They do joint work with groups doing landuse and grassland work. The ties to the TDD appear tenuous at the technical level.

11. **Promising Areas of RS Work/R&D:** Landuse mapping and coastal zone mapping are world class.

12. **Impact of IDRC Project:** This group tends to employ Peking graduates. The higher level of graduate with DIPIX training will improve their capability. Research project linkages should be enhanced given similarly of hardware and the linkages being established between ID and Canadian groups.

13. **Primary Areas for Exchange with Canada:** We may benefit from their large region visual studies, while Canadian experience in large region fast-turnaround digital analysis should be useful.

1. **Institution:** Agricultural University

2. **Ministry:** Agriculture with linkages to education.

3. **Mandate:** To teach agriculturally oriented people in agriculture, fishing, animal husbandry and rangeland.

4. **Senior Officials:** Prof. Yu He Quan (Physics) and Prof. Dr. Li Lianjie (soil science, Vice Dean of graduate school, member, Academic Sinica).

5. **Lines of Authority/Organization:** The R&D Institute for RS is independent of any university Department. It reports through agriculture. This linkage explains FAO support.

6. **Staff/Qualifications:** Prof. Li has a Ph.D. (circa 1940) from Illinois. He offers an intelligent reflective view. There are five faculty members with a range of practical experience. Five faculty members in soil science also help in the courses. One staff member spent time at LARS (Mr. Lu).

7. **Project Work:** Grassland assessment for biomass (with radiometers), crop identification and yield using USA methods; monitoring saline soil; soil survey in Inner Mongolia. A major problem is geometric correction in featureless plains. Major R&D is now being done in rice yield, with minor work in wheat yield.

8. **Equipment:** DIPIX ARIES-II, Kargyl Projector, stereo transferscope, and colour additive viewer. The facility was largely funded through UN/FAO in Rome.

9a **Training:** The first training course was offered in 1979, helped by three faculty members from TTD. The second course was given in 1981 - Mr. Yu was involved in this. Forty recently attended a two week digital course. Drs. Crown (Alberta) and Kalensky (FAO/Rome) gave a course for the FAO in 1983.

b **Education:** The Applications and Training Institute is set up as an R&D institute separate from the University. Students are recruited each year by the Ministry of Agriculture. There are 12 post-graduate students, 4 have completed Masters level studies to date. The University had 4000 students before the Cultural Resolution closed the school - now there are 1000.

10. **Relationship to Other Program(s):** It advises TTD on agricultural programs and students and staff work closely on each other's programs. Director Chen (TTD) was a student of Dr. Li's when the Agricultural University was part of Peking University.

11. **Promising Areas of RS Work/R&D:** Saline soil monitoring, the use of RS for an aid in soil survey; soil erosion studies and integrating RS into agricultural studies.

12. **Impact of IDRC Project:** Both TTD and the Agriculture people would have similar systems, already have close ties and might be expected to develop agricultural applications faster. TTD would benefit from the previous experience of this group.

13. **Primary Areas for Exchange with Canada:** All of the above areas of application under 11 would be of interest. Canada's work with NOAA monitoring would also be useful, as would our crop area estimation and concepts of uniform productivity.

14. **Misc. Information and Comments:** Some very thought provoking comments on the use of RS for agriculture were made by Prof. Dr. Li. How should it be used? How useful are pretty maps - more easily (or accurately) made by other methods. Mapping arid land doesn't solve the problem of aridity - nor does mapping of eroded or saline soil solve those problems. RS should be integrated into on-going studies as an adjunct to other methods. If it tries to stand alone, it will suffer from poor results and resulting would be a lack of confidence.

1. **Institution:** Petroleum Institute

2. **Ministry:** Petroleum

3. **Mandate:** To serve problem exploration and development

4. **Senior Officials:** Mr. Wang

5. **Lines of Authority/Organization:** Reports through Scientific and Research Development for Petroleum. The group was formed in 1978.

6. **Staff/Qualifications:** There are 52 staff. A number appear to be well qualified with a great deal of practical experience.

7. **Project Work:** They have CCT's for all of China with exploration in the NW & SW as the focus. Two major faults have been found in the NW (a P-C transformation is the basic tool). Studies have also been done on geomorphological change of the Yellow River, coastlines (work with Japanese oil exploration firms and others), etc.

8. **Equipment:** I^2S-System 70 (two systems), Applicon. The I^2S is used 10-14 hours per day (screen time) six days per week and 24 hours per day with background work included. One-third of the system time is for preprocessing and geometric processing, one-third for internal users and one-third for external users.

9a **Training:** They offer internal courses and courses for external users of their systems. A total of thirty other groups use their system and participate in courses.

b **Education:** Some graduate students are attached to the institute, but the emphasis appears to be on staff work. The work is not at a very high technical level, nor does it appear as innovative as work done in some other areas. However, it also does not appear to suffer any major short comings.

10. **Relationship to Other Program(s):** Many others use the I^2S systems - on a cost recovery basis. Mr. Wang of TTD is a major user. They hire students from a variety of universities - including their own. They appear to closely co-operate (in terms of equipment use) with more agencies than any other group in China. One of two Nanjing M.Sc. graduates used their system for his work.

11. **Promising Areas of RS Work/R&D:** The work I saw was not technically advanced - but it appears to fill a need and is being used. This cannot always be said for many similar groups in Canada.

12. **Impact of IDRC Project:** There would be some off-loading from their system, now used to capacity. Some graduates of Peking University may be more useful as employees with new and better training - even if trained on a different system. The general impact would likely be slight.

13. **Primary Areas for Exchange with Canada:** They may benefit from learning some of our methods for glaciated areas, while there may be some benefit to us in studying their exploration methods.

14. **Misc. Information and Comments:** The first three year stage was R&D in visual interpretation of LANDSAT. Now they are in the second stage using digital data. Presentations on their work took up most of the time, leaving little time for detailed questions on their program and how it relates to others, for example.

1. **Institution:** Remote Sensing Application Centre

2. **Ministry:** Water Resources and Electric Power

3. **Mandate:** R&D of methods and applications relating to water resources (including irrigation, soil salinity and hydro).

4. **Senior Officials:** Mr. Yang Jicheng, Chief of Remote Sensing

5. **Lines of Authority/Organization:** The Ministry has six units: river basin units for the seven major rivers; surveys and design for water resources, hydro and electricity; scientific/R&D e.g. East China College of Hydrology in Nanjing; Provincial water resources; and power plants. This group reports through the third, but serves all.

6. **Staff/Qualifications:** Mr. Yang and his 15 staff appear to be highly knowledgeable users. They have been involved in RS as long as the NRSC. They hope to double their staff in the next year or two. They have to graduates from Peking's program, and some from Tsing Hua (software), Agricultural University, and Beijing Normal School.

7. **Project Work:** R&D work on SAR and SLAR dam site location on Yangtze River (LANDSAT for faults, etc.); floods; lake and reservoirs-silting, size and dynamics; power plan location; saline soils; soil erosion; software for boundary locations of polygons (on ERDAS system); proto operational/operational work on using NOAA-7 for multitemporal flood monitoring (up to 4 image overlays); water depth; mapping of 18 classes - 6 of them on erosion levels - for all of China; wetland/agricultural changes.

8. **Equipment:** Optronics Analysis System/ERDAS (since 1981); optronics scanner; I^2S colour additive viewer; LogE printer; full darkroom/enlarging facilities; 2 DIPIX systems (at Nanjing and Wuhan); NOAA analogue reception station (on building's roof); access to digital NOAA reception (with plans to upgrade their station to digital).

9a **Training:** They have run three workshops (50 people each) and have internal training as well. Their staff also lecture to others outside.

b **Education:** They have no formal education programs.

10. **Relationship to Other Program(s):** They have relationships with a variety of other users and the NRSC. They do not appear to have a particularly close relationship with the NRSC as a whole - only to the TTD.

11. **Promising Areas of RS Work/R&D:** All of their projects appear to be generating useful results.

12. **Impact of IDRC Project:** The Centre states that they are ready to receive and use the technology - but are not able to because of limited staff. The IDRC project may help them remedy this problem - especially given the fact that they have DIPIX hardware.

13. **Primary Areas for Exchange with Canada:** Mr. Yang toured Canada in May of 1983 and discussed a variety of common interests. Except for more sophisticated Met data processing; there is little more he can learn from us.

1. **Institution:** Tsing Hua University

2. **Ministry:** Education

3. **Mandate:** R&D and education in Radio Electronics and RS Signal Processing

4. **Senior Officials:** Prof. Wu You-Shov (Director of Radio Electronics)

5. **Lines of Authority/Organization:** There are eighteen depts. and a school of management. All but three are involved in electronics, engineering, physics and instrumentation. There are 10,000 undergrads, 800 M.Sc. students and 40 Ph.D students. The 3000 staff include 104 full profs., 700 Assoc. Profs. and lecturers. There are 10 groups in radio electronics. The first is Image Processing with 40 staff. The second is Telecommunication covering digital communication, coding and microwave relay. The third group is Circuits and Systems (including CAD), while the fourth is Signal Detection (radar/EM fields/microwave scattering). The other five include Electronic Physics, Laser Physics, Industrial and Medical non-destructive testing.

6. **Staff/Qualifications:** Prof. Wu studied with Rosenfield in the USA. Many have been sent abroad - USA, France, UK(2) and Canada (U. of T.).

7. **Project Work:** Under Ms. Zheng (of NRSC) they are designing a digital analysis system like the I^2S using an 11-23 as host with 4 refrsh memories. They are also doing image classification with software, and working with Forestry in northern China and hydrology (with Water Resources). Funding has come from SSTCC, Ministry of Education, and Hydrology. World Bank support was used for the DIPIX system.

8. **Equipment:** A large DIPIX system has been purchased (larger than any system in any university in Canada).

9a **Training:** Training courses are run sporadically. They are in the process of developing a school of continuing education to do more training.

b **Education:** The undergraduate program is 5 years, 2 semesters per year. The last semester is devoted to a research project - ten of these per year are on RS. Only two undergrad courses are given relevant to RS - digital signal processing and computer languages(?). Five graduate courses are given: RS, Image Processing, Statistical Pattern Recognition and Computer Vision. Tsing Hua professors advise students at Peking (e.g. graduate R&D on mixed pixels) and there is joint work on the design of RS processing systems.

10. **Relationship to Other Program(s):** As noted above, they have close ties to the NRSC and to Peking University. They also have ties to user agencies in various ministeries.

11. **Promising Areas of RS Work/R&D:** Linkage is planned between their DIPIX system and the potential one at Peking University. The level of R&D seems rather lower than one finds in Canadian labs - although the new DIPIX system should help to advance them rapidly.

12. **Impact of IDRC Project:** Peking University would be able to receive developments done at Tsing Hua and in turn, Tsing Hua would get better advice on useful avenues to pursue.

14. **Misc. Information and Comments:** From the physical space available, Tsing Hua will have the largest image processing lab I have ever seen.

1. **Institution**: Nanjing Institute of Geography

2. **Ministry**: Academia Sinica

3. **Mandate**: The mandates of the six Departments (Economic, Physical, Cartography, Hydrolimnology, Hydrobiology/ecology and Lake Sedimentation) vary. Cartography compiles thematic maps, while the three limnology departments are the centre of limnology in China. Only the Institute of Geography is Beijing is comprehensive in scope - all others have specific areas of study.

4. **Senior Officials**: Mr. Pu Peimin, Vice Director (limnology), Mr. Zhang Longsheng and Mr. Yang Jinhua.

5. **Lines of Authority/Organization**: Funding and direction come from Academia Sinica, some local government and limited support from the NRSC. (In kind services/training). There is very limited external aid.

6. **Staff/Qualifications**: There are 257 staff-12 professors, 160 research and technical employees, 50 administrative and 18 post-graduates. In cartography, there is one associate professor and four others doing RS. One other professional works in hydrometeorology and RS while the only other staff member involved in RS is in Economic Geography - he studied at ITC.

7. **Project Work**: Cartography is the primary RS user. The focus is on land capability (begun in 1977 with air photos), land/water resources in the reclaimed coastal zone of the East China Sea, and developments around the large lake south of Nanjing. A landuse map, geomorphologically stratified, was made for the local province from LANDSAT. It has 30 classes. (It does not duplicate the more general map made by ID of NRSC - it had but nine classes in the region). The 30 classes provide further details in the major classes of agriculture, gardens, forest, grasslands, water/wetland, cities/urban industry, tourist/protected. They have not yet had the opportunity to use multitemporal data. They have used astronomy's digital image processing hardware, but not the water resources DIPIX system at Nanjing.

   Water resources work has been done with the Lake Water Resource Institute of the Ministry of Water Resources and Hydro Electric Power. They have looked at reflectance and compared to aerial photographs to get depth and volume (but only in reservoirs). They have also related reflectance to plankton and water quality. They have used an IR scanner for temperature studies, and LANDSAT for water penetration. Overflights and ground (water) data acquisition are simultaneous.

   They have also taken part in the field work in the integrated test site established in southwest China by various institutes.

They note that they will change their R&D and project emphasis to those the province will fund. The province's planners are their primary "users".

8. **Equipment:** A Chinese colour additive viewer, I^2S density slicer (poorly maintained and improperly handled), map printer, large format colour map camera (made in Shanghai). The CAAC flies airborne data on contract. The imagery is processed by TDD.

9a **Training:** They take courses. Five attended courses at TTD and ID in the past year. (Including my fourth year level "RS applications" course).

b **Education:** There is one graduate student and no courses.

10. **Relationship to Other Program(s):** They work with the Provincial government (primarily), Water Resources, TDD, TTD (as students), and the Cartographic Publishing House.

11. **Promising Areas of RS Work/R&D:** The work with landuse and reservoirs is promising, but the latter is at a low technical level.

12. **Impact of IDRC Project:** Although the project would provide better training, its effect would be lost unless the group here uses the system owned and operated in Nanjing by Water Resources. Such use does seem possible - but bureaucratically complicated.

13. **Primary Areas for Exchange with Canada:** They could use the chromaticity work by Alfoldi - they are not familiar with it.

14. **Misc. Information and Comments:** This group is similar to those in Canadian areas away from the large R&D groups. It is busy using the technology - often in innovative but simple ways, but always with short term, practical goals in mind.

This group has closer ties to the TDD than many in Beijing - likely because both are Academia Sinica. Otherwise, there appears to be great enthusiasm which is overwhelmed by isolation.

1. **Institution:** Dept. of Geography, Nanjing University

2. **Ministry:** Education

3. **Mandate:** Education and R&D

4. **Senior Officials:** Assoc. Prof. (geology/physical geography) Yang Wu (Director, RS); Prof. Chen Bingxian (Deputy Head of Geography, Assoc. Director, RS). Also in RS are Assoc. Professors Chen, Yien and Yan.

5. **Lines of Authority/Organization:** RS crosses three of sixteen Departments - Geography, Physics and Meteorology. Computer science is also involved. The Geography Department is described below under section 14.

6. **Staff/Qualifications:** The RS group was formed in 1977. There are nine teachers. They have been doing photo-interpretation since 1950 and seem to be a well qualified group in the traditional fields. Questions and discussions were at a high level.

7. **Project Work:** A wide variety of projects have been completed or are ongoing. In the 1950's/60's - variation of the Yangtze River, sand dune movement, land use in the mountains. Since 1977 - estimation of water surface area, coastal studies, geomorphology, map making (land use at 1:1,000,000), land resources (one Prof. is studying at Reading, UK), urban climate (with NOAA) and equipment design in physics.

8. **Equipment:** 16 step density slicer (one of 10 made with the Geography Department's design); colour additive viewer - one of fifteen made; for photogrammetry a rectifier, comparator and plotter; for cartography an IBM PC (230 kilo bytes); for RS a $15 K (US) Durst enlarger.

9a **Training:** A few courses have been given in Shanxi province (with Peking University) and some on their own for a provincial Geological Bureau and a Water Resources Department.

b **Education:** They offer two undergrad courses (mandatory for all geographers) - RS Principles, and Photo Interpretation. They also offer four grad courses one or two semesters in length: resources RS, digital analysis, cartography and RS, and image interpretation. To data there have been 2 M.Sc. grads. One is in a geological survey in a province (thesis topic: image analysis for geology - in conjunction with the Petroleum Institute); the other did visual interpretation of coastal areas and is doing work at Santa Barbara. Students come from geography and physics programs from all over the country.

10. **Relationship to Other Program(s):** They have no facilities and work with whomever is necessary to meet their objectives. They are forward thinking and outward looking. They have ties of one sort or other to every group visited.

11. **Promising Areas of RS Work/R&D:** Landuse in subtropical moutainous regions, soil salinity, soil erosion, and water resources.

12. **Impact of IDRC Project:** The Nanjing program is now almost as strong as Pekings (in equipment) and has within it some excellent people. The project will widen the gap and will likely lead to a reduction in the relative stature of Nanjing's program. It will also spur them to seek other assistance (such as World Bank) to improve their equipment.

13. **Primary Areas for Exchange with Canada:** Their problem conceptualization is strong, their resources for solving problems are limited. Student/faculty and technical information exchange would be beneficial. An exchange in urban/planning with Waterloo would seem to be logical.

14. **Misc. Information and Comments:** The Geography Department is one of the largest I have ever heard of. There are 30 professors and associate professors, 64 lecturers and 31 assistants. There are five post-graduate specialities. Of these, two (Urban Planning and Oceans) offer Ph.D. studies. In addition, there are four study groups - Africa, Ocean Geomorphology, Environmental Geography and Remote Sensing. There are 314 students - with 43 at the M.Sc. level. The Department's R&D work focuses on ocean geomorphology, urban planning, computer cartography, RS applications, thematic mapping, natural resources and sedimentology.